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The Spokesman

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Launching 10,000-Ton Cargo Vessels

By Paul G. A. Brault, m.e.i.c., *United Shipyards Limited, Montreal*

The six-berth shipyard at Bickerdike Basin, Montreal, known as United Shipyards Limited, was built for the purpose of producing 10,000-ton cargo vessels. During construction of the yard it was necessary to determine the length, position and make-up of the launching groundways and also the excavations needed to provide launching clearances.

To this end complete launching calculations were computed. These calculations served for the design of the launching cradle and launching arrangements as well.

The Vessel

The principal dimensions of the vessels to be launched are as follows:

Length between perpendiculars	416 ft.
Length from stern to aft perpendicular	17 ft. 6½ in.
Length from fore perpendicular to bow	7 ft. 10¼ in.
Length overall	441 ft. 4¾ in.
Midship moulded breadth	56 ft. 10½ in.
Midship moulded depth	37 ft. 4 in.
Rake or F.P. to intersection of keel and stem bar	7 ft. 9 in.

A table of offsets lifted from the loft floor defined the moulded shape of the hull. From this table a series of Bonjean curves were established which permitted the calculation of buoyancy and centre of gravity of buoyancy at any displacement desired.

The vessels are erected with keel line at a slope of ⅜ in. to the foot, and the intersection of the aft perpendicular with the keel line is at elevation 100.0 ft.

The Yard

The disposition of the six berths is shown in Fig. 1. The relationship of the two groups of three berths was governed by the local rock contour of the site. The dark hatched areas represent the crib cofferdam necessitated by seasonal water level variation. In way of each berth the cofferdams are joined by a series of removable bents and stoplogs. This distance from face of stoplog to aft perpendicular during construction is 58 ft. The clear distance between cofferdams when bents and stoplogs are removed is 65 ft.

Several features of the yard affected the design of the launching arrangements. Although the water in the basin is tideless, its elevation during the launching season (Apr. 15th to Dec. 15th) may vary from elevation 106 to elevation 92 minimum. The summer average is approximately at elevation 95. At the first winter freeze up, however, the water may rise to elevation 116. This condition required the building of a watertight cofferdam system which would permit hull construction during the winter months.

The jagged rock bank on the east side of Berth No. 3 left after excavating for launching clearance extends about 250 ft. beyond the end of groundways and parallels the berth about 35 ft. from its centre line. This leaves only 6 ft. clearance during a launch and the danger of any loose cradle timber becoming snagged made it advisable to design the launching cradle in such a manner that all parts be thoroughly secured and that the removal of the cradle after launching be controlled.

At this same berth the lack of water between the vessel and the bank during a launch sets up a transverse head which causes the vessel to move towards the bank immediately after leaving the groundways. In order to protect the hull from damage a timber guard was built off the adjoining cofferdam.

The vessel when launched offers about 12,000 sq. ft. of exposed surface to prevailing east or west winds. The basin is narrow and presents a limited area for tugs to manoeuvre in. These facts made it desirable to apply drags to the vessel to bring it to rest immediately after the launch.

Static Launching Calculations

Calculations of moments of vessel's weight and buoyancy about the fore poppet and end of groundways for various travels were made. These computations were based on the following assumptions:—

Launching weight of vessel	2,430 long tons
Weight of launching cradle	90 long tons
Declivity of vessel and groundways	⅜ in. per ft.
Camber of groundways	nil
Length of groundways aft of A.P.	180 ft.
Distance from keel to sliding surface	3 ft.
Elevation of water	92.0 ft.

Beginning with this issue of the SPOKESMAN and continuing until completed, we will publish a complete story on launching of ships.

After the completion of this article, it will be followed by Mr. Bohmer's paper on Launching Greases.

The Editor

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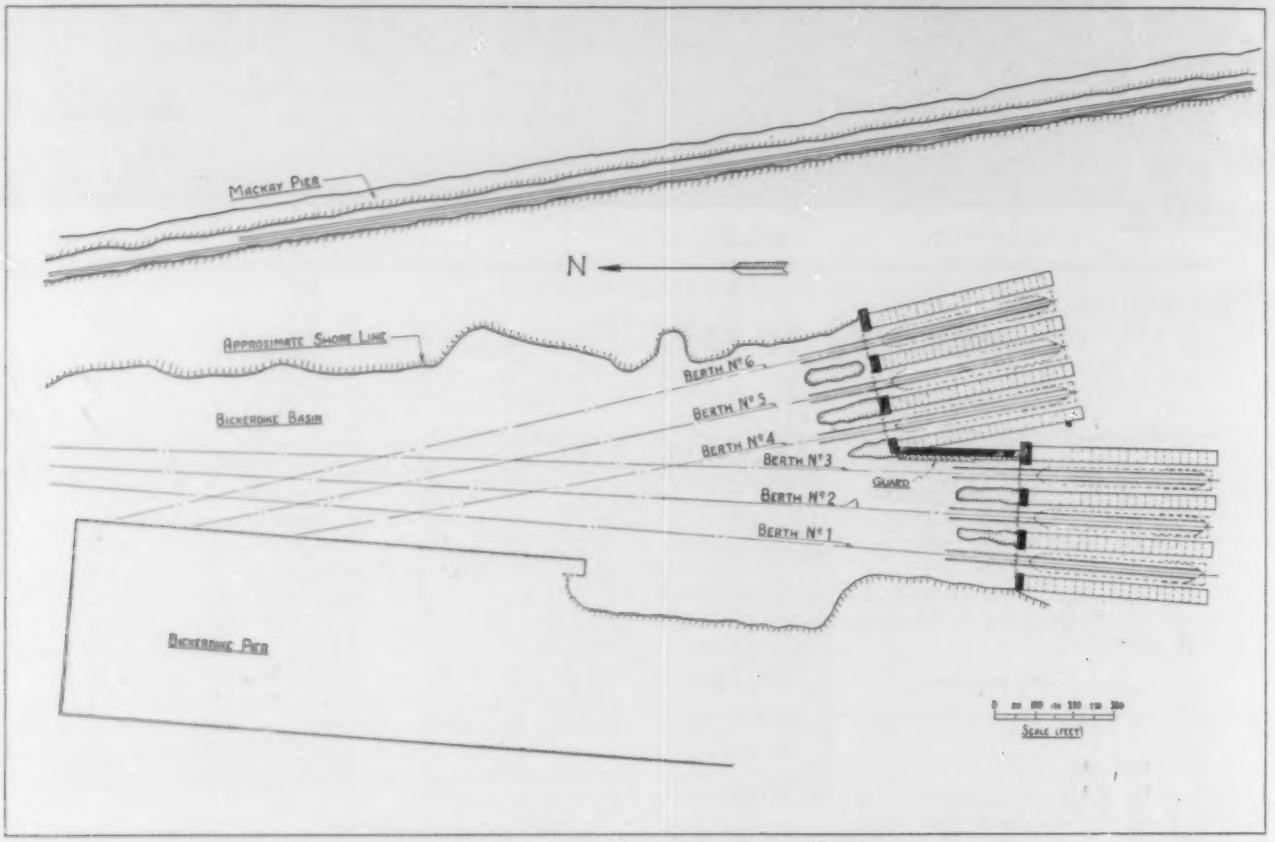

Fig. 1—Arrangement of building berths at Bickerdike Basin.

The results of these calculations are plotted graphically in Fig. 2, and indicate the maximum static fore poppet load to be about 750 tons and the margin against tipping about the end of groundways to be about 82,000 ft.-tons.

The curves show the variation of load on fore poppet during launching due to weight (W) and buoyancy (B), also the moments of W and B about the centre of fore poppet and about the after end of groundways (EOGW). They indicate that pivotting occurs at a travel of 433 ft. after start of launch. A one-foot rise or fall in water level would shorten or increase the travel by 19.2 ft.

Assuming a straight line variation of pressure on the overlap on the groundways, calculations showed a maximum way end pressure of 5 tons per sq. ft. Under normal conditions, i.e., water at elevation 95.0 and length of ways aft of A.P. of 230 ft., the indicated way end pressure was under 3 tons per sq. ft.

At the theoretical pivotting position the draft at the aft perpendicular figured at 14.5 ft. Assuming a 100-ft. over-run beyond the theoretical pivotting point, the draft would be 19.7 ft. This latter figure was used to determine the required excavations of the basin needed to provide launching clearance.

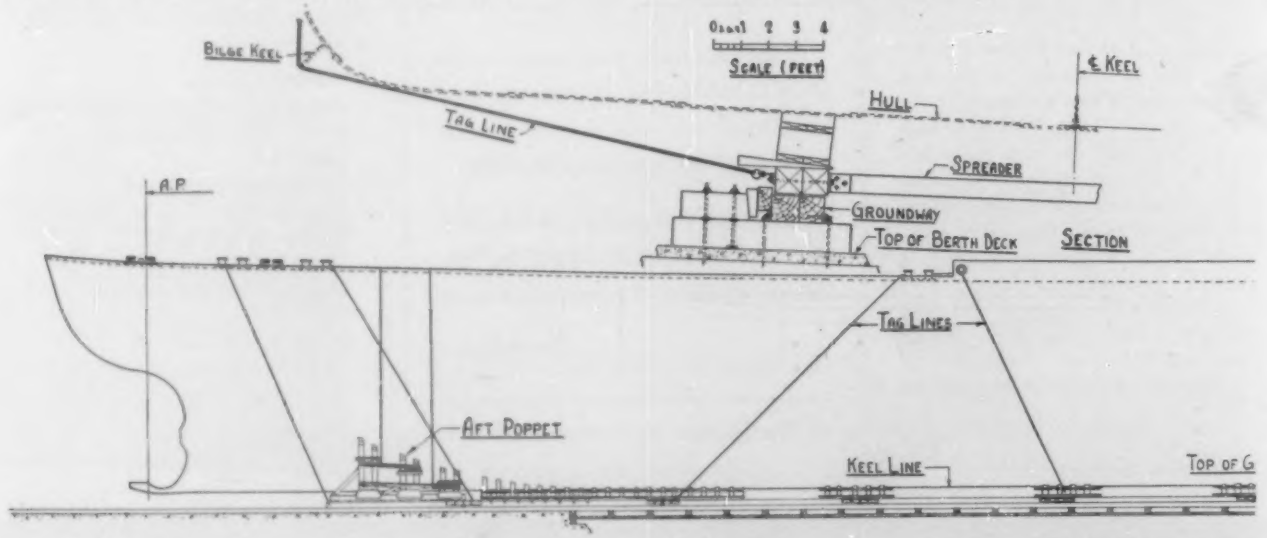

Fig. 3—General arrangement of

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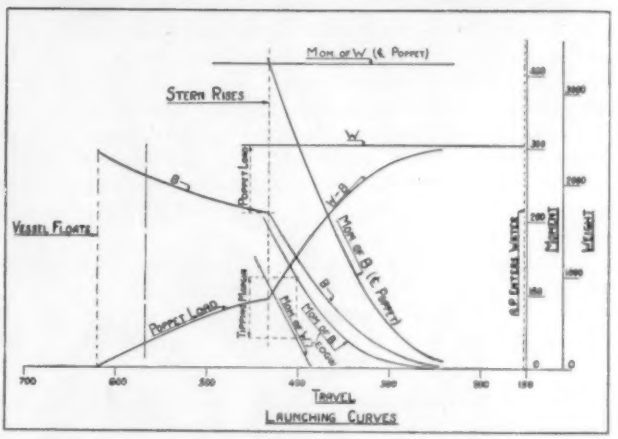


Fig. 2—Launching curves showing the forces and moments acting on vessel during launching.

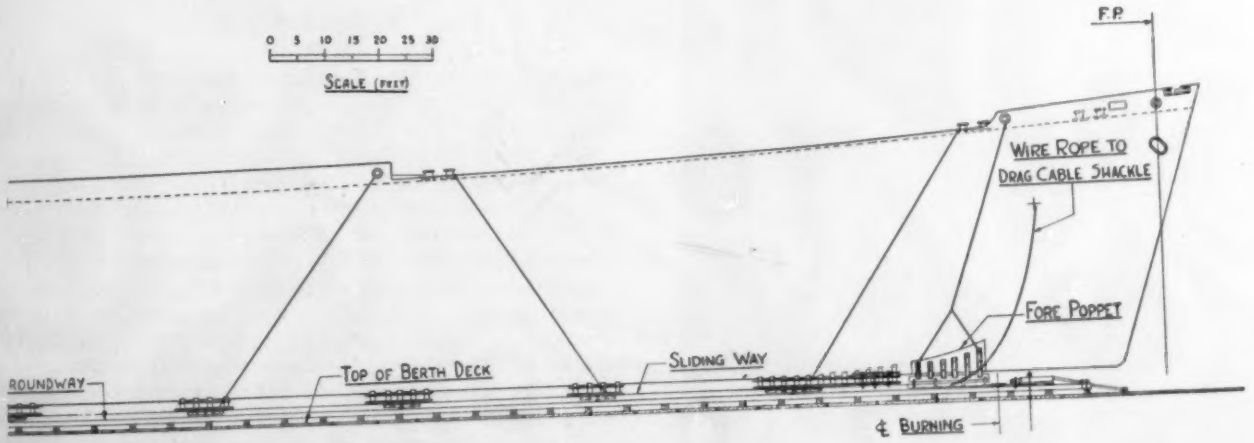
THE GROUNDWAYS

The two groundways on each berth are at 20 ft. centres and extend from the bow to approximately 230 ft. beyond the aft perpendicular. Their over all length is about 630 ft. They are straight and without transverse inclination or longitudinal camber.

The width of each groundway is a function of the launching weight (2,520 tons), length of sliding ways (349 ft.) and the desired initial mean pressure (2.0 tons per sq. ft.) Thus the width required equals:

$$\frac{2520}{2.0 \times 349} \times \tfrac{1}{2} \times 12 = 21.7 \text{ in.}$$

Each groundway consists of two continuous rows of 12 by 12 dressed B.C. fir timbers placed side by side with staggered butt joints and bolted with through ¾ in. bolts at about 42 in. centres. A 6 by 12 ribband, extending 3 in. above the top of the groundways, runs



cradle, showing ways and poppets.

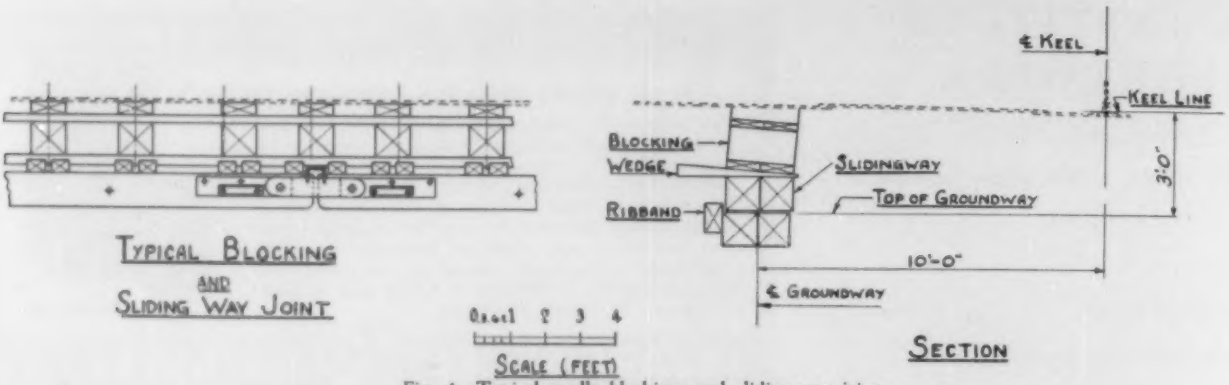


Fig. 4—Typical cradle blocking, and sliding-way joint.

continuously on the outboard side and is wedged at 7 ft. centres to anchored timber blocks. The dressed size of the timbers being 11½ by 11½ in., the width provided equals 23 in. less 1 in. ribband clearance, or 22 in. net.

A temporary cofferdam was built to permit construction in the dry of the aft end of groundways. After completion, this cofferdam was removed, thus permanently flooding the area. The aft 307 ft. of ways are laid on continuous concrete pedestals poured upon rock. The remainder are supported on the berths' timber bents (7 ft. centres) which are also on rock foundation. The rock between the ways was excavated for a distance of 28 ft. forward of the end of groundways to provide clearance for the drop of the vessel in the event of launching at minimum water level.

In anticipation of possible heavier launchings in the future, the submerged length of the groundways was built 6 in. wider than the forward portion. A removable filler piece was inserted along the ribband to align with the ribband on the remainder of the ways.

THE RELEASING ARRANGEMENT

There are two common methods of controlling the force component down the ways. They are the releasing trigger and the burning sole plates. The latter method was adopted at United Shipyards Limited due to its extreme simplicity and its ready adaptability to prevailing conditions. Although the sponsor does not actually release the vessel as is the case usually with the trigger, the method adopted is not without its interest value as the burning of the sole plates is a point of unfailing attraction to all who witness the launching.

The sole plate, one at each sliding way, is a steel plate bolted to two holding plates, one of which is bolted to the forward end of the sliding way and the other bolted to the groundway as described later

Fig. 5—Starboard aft poppet showing wire rope arrangements for its salvage.

under "Fore Poppet" and shown in Fig. 6. The net section and bolting of each sole plate is designed for one half of the total force component down the ways, neglecting friction on the groundway lubricant.

The force component down the ways (F) is equal to the launching weight times the sine of the angle of declivity of the ways, or $F = 2520 \times .052 = 131.6$ tons. It is transmitted to the sliding ways by friction between the hull and cradle and reacted by the rock foundation through the berth structure and compression in the groundways.

The centre of each sole plate is perforated with twelve 11/16 in. diameter holes at 1½ in. centres. The spaces between holes are numbered consecutively from the outer edges of the plate towards its centre. In this manner the burning of both sole plates is more readily controlled and uniformity of remaining section in each plate assured.

The area of metal broken gives a measure of the actual force acting upon the vessel.

THE CRADLE

The general elevation in Fig. 3 indicates the three principal parts of the cradle, built between the sliding ways and the vessel. They are the aft poppet, the main blocking and the fore poppet. The midship section shows how the wire rope tag lines and the sliding way spreaders combine to prevent any transverse movement of the cradle during the launch. All individual parts of the cradle, such as wedges, planks, blocks, etc., are thoroughly tied to the sliding ways. This assures complete salvage of all items as well as preventing any part floating away separately while the vessel is entering the water. The 1 in. wire rope connecting the forward sliding way section to the drag cable shackle serves eventually to anchor the cradle to the drag after the vessel has come to rest.

THE SLIDING WAYS

The total length of each sliding way, one on the port groundway and the other on the starboard, is 349 ft. Each is made up of nine sections 36 ft. long and one aft section 25 ft. long. Each section consists of two 12 by 12 dressed B.C. fir timbers bolted together with through ¾ in. diameter bolts at 51 in. centres. The length and position relatively to the vessel of each sliding way is determined by practical considerations of the fore and aft poppet construction.

The design of the joint connecting each section of sliding way to the succeeding section is of prime importance due to the type of releasing arrangement adopted. Conceivably, if a joint were not adequate, the vessel might launch itself by merely breaking down its friction on the cradle forward of the weak joint. Thus the fore poppet would be left behind thereby causing probably disastrous results.

A joint is designed for one half the force component down the ways, neglecting the lubricant friction, less the friction between the hull and cradle forward of the joint being considered. The first joint forward consists of two link plates which engage a 3 in. diameter

through pin in each adjoining section. Each through pin in turn engages two side plates which are adequately bolted to its section. The second joint from the forward end is similar to the first joint but with 2 in. diameter through pin and smaller side plates. To permit interchangeability of sections, all remaining joints are made the same as the second joint (see Fig. 4). Two of the side plate bolts at each joint engage an angle on the outboard side. This angle has a hole in its outstanding leg which serves to connect the tag lines and tie up cradle components.

Each port section of sliding way is connected to its corresponding starboard section by two 8 by 8 timber spreaders positioned at the third points.

The sliding ways are spaced 1 in. clear of the groundway ribband by means of thumbplates. These thumbplates are steel plates 1 in. thick by 2½ in. wide, bent into the shape of an angle 2½ by 1 in. Two thumbplates are placed at each sliding way section. They are all numbered and are carefully checked when removed just prior to launching in order to make sure that none have remained in place.

The one inch space between the groundway ribband and the sliding way is covered by a ¼ in. wood strip for the full length of the cradle. This is a precaution against nuts, bolts, washers, etc., becoming lodged in the clearance space during the construction period of the cradle. These covers are removed just before the thumbplates are taken out whereupon a last inspection of the clearance space is made before launching.

Cradle Blocking

Typical cradle blocking is shown in Fig. 4, and occurs at each hull frame. The blocks between the two layers of longitudinal 3 by 12 planks are 12 in. by 12 in. by 2 ft. long. The fitting block is also 12 in. wide. The wedges are cut from 4 by 6 in. hard wood, 3 ft. 6 in. long and have a slope of 1 in 12 in. The four corners of the driving end of each wedge are chamfered. The sliding way joints provide 1 in. clearance between sections. The ends of all sliding way sections are rounded at the lower edge to prevent scoring of the groundways.

The Aft Poppet

The maximum strain on the aft poppet occurs after the stern keel blocking has been removed and remains until the aft poppet passes beyond the end of groundways. The load it must carry is indeterminate but it must support the overhang of the vessel aft of the poppet. This overhang is about 56 ft. at the upper deck and about 39 ft. at the keel line.

The cradle is removed from under the vessel by anchoring the cradle to the drag blocks and having the tugs haul the vessel off by the stern. The keying action of the aft poppet on the finer lines of the vessel's stern made it necessary to construct the aft poppet in such a manner that it would remain with the vessel during this hauling off operation. As shown in Fig. 5, the aft poppet is therefore built as a separate unit, free from the sliding ways at the bottom of its wedge riders and tied to the vessel by two ¾ in. wire ropes on each side. The six vertical members with bracing longitudinal channels and wedge rider are built and handled in one piece. The saddle plates, tie rods and angles, etc., are assembled separately. Note the wire ropes connected to the poppet distinct from the tag lines connected directly to the sliding ways. To salvage the aft poppet the wire rope tag lines are thrown off and the poppet allowed to sink to the bottom of the basin at a convenient spot, the proportion of steel in the unit being purposely sufficient to assure the unit will not float. Buoys at the ends of the wire rope tag lines serve to spot the position of the poppet whereupon it is raised from the bed of the basin by a floating crane.

The very purpose of the shipyard dictated that all cradle parts be so proportioned that they could be reused repeatedly. For this reason the vertical uprights of the aft poppets are capped with a cross timber instead of running up directly to the hull. These cross timbers serve as fitting pieces and can be readily replaced for adjustments on different vessels, thus preserving the main structure intact.

The Fore Poppet

The fore poppet is the bearing about which pivotting of the vessel occurs during launching. The poppet must provide the means of pivotting and at the same time properly distribute the resulting concentrated load to the groundways. Both of these functions are obtained by the use of crushing blocks.

The fore poppet and releasing arrangements are shown in Fig. 6. The sliding way holding plate and sole plate are 23 in. wide and ½ in. thick. The groundway holding plate is 24 in. wide due to the 1 in. difference of centres between the sliding way and groundway. Should the starting friction on the lubricant be too high, two 100-ton hydraulic jacks are provided, one at each groundway, which are connected to a single pump. The tie down is to take care of the local moment set up by the sole plate load being reacted at the centre of the groundway. Note the connection on the outboard side of the sliding way used to anchor the cradle to the drag blocks after the launch.

(To be continued)

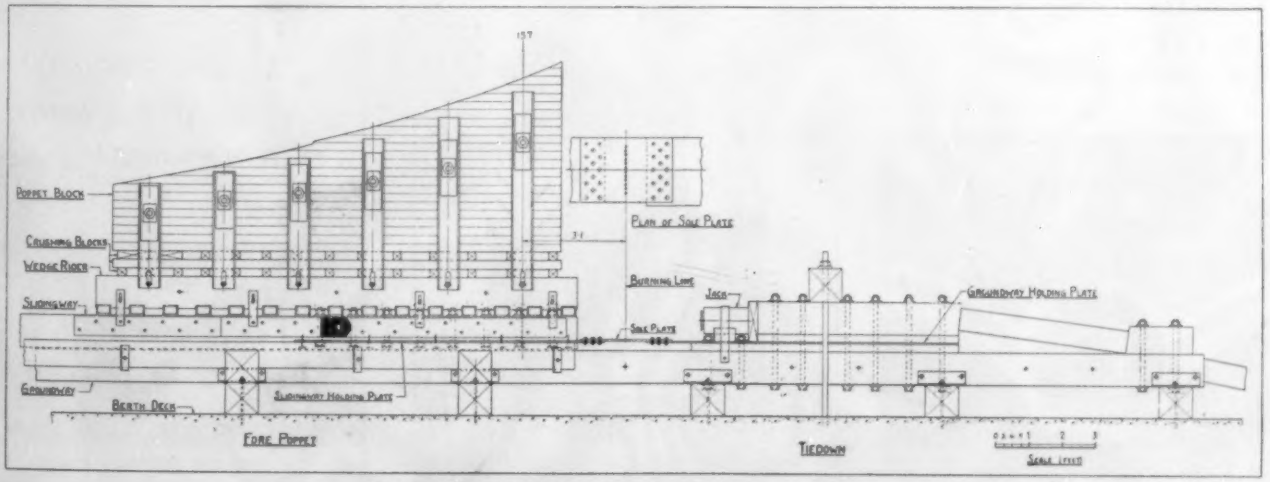


Fig. 6—Elevation of fore poppet and releasing arrangement.

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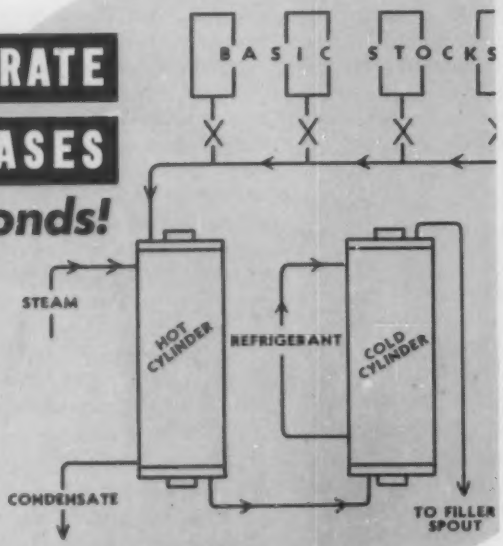

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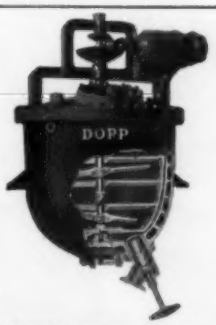

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